



PG&E 2020 Risk Assessment and Mitigation Phase Workshop #3

February 4th, 2020





Agenda

1 Introduction – 60 Minutes

Purpose of Workshop

Recap of MAVF and MARS Methodology

PG&E RAMP Selection Criteria

Safety Risk Register

Transition from 2017 RAMP to 2020 RAMP

Cross Cutting Factors

Preliminary RAMP Risks

2 RAMP Risk Presentations – 12 Risks * 20 minutes

Power Generation (PGEN)

Shared Services (SS)

Gas Operations (GO)

Safety, Health, ECAP, and DOT (SHED)

Electric Operations (EO)

3 Questions and Closing

1. Introduction



Purpose of Workshop

Consistent with the S-MAP SA, Item No. 12:

...the utility will preliminarily select risks to be included in the RAMP. The utility will host a publicly noticed workshop, to be appropriately communicated to interested parties...to inform the determination of the final list of risks to be included in the RAMP. ...

Based on the input received from SED, other interested CPUC staff, and interested parties, the utility will make its determination of the final list to be addressed in its RAMP. The rationale for taking or disregarding input during the workshop will be addressed in the utility's RAMP.

Purpose

To gather input from SED, other interested CPUC staff, and interested parties on PG&E's selection of risks to be included in the RAMP



Workshop #2 Recap: MAVF Specification

Attribute	Range	Natural Units	Weight	Scaling Function
Safety	0 - 100	Equivalent Fatalities (EF)/event	50%	Non-Linear
Electric Reliability	0 – 4 Billion	Customer Minutes Interrupted (CMI)/event	20%	Non-Linear
Gas Reliability	0 – 750,000	Customers affected/event	5%	Non-Linear
Financial	0 - \$5 Billion ¹	\$/event	25%	Non-Linear

Equivalent Fatalities (EF) is defined as the sum of Public, Employee and Contractor Fatalities and Serious Injuries per event occurrence. Serious Injuries are defined as situations that require in-patient hospitalization of an individual. Serious Injuries are converted to EFs using a factor of 0.25 EF/Serious Injury.

¹ Pursuant to D.18-12-014 and D.16-08-018, shareholders' financial interests are excluded.



Multi-Attribute Risk Score and Safety Risk Score

Consistent with the S-MAP SA, the risk scores are the product of the Likelihood of a Risk Event (LoRE), and the Consequence of a Risk Event (CoRE), $LoRE \times CoRE$, per unit of Exposure, i.e.,

$$\textbf{Multi-Attribute Risk Score (MARS)} = \textit{Exposure} \times \textit{LoRE} \times \textit{CoRE} = \textit{Frequency} \times \textit{CoRE}$$

where

- Frequency is the product of the Exposure and LoRE.
- CoRE is the weighted sum of Scaled Units of four Attributes, multiplied by 1,000.
- The Scaled Unit of each Attribute varies from 0 to 100, consistent with its definition in the S-MAP SA and is the output of applying the MAVF's Range and Scaling Function to the Attribute Levels.

$$\textbf{Safety Risk Score} = \textit{Exposure} \times \textit{LoRE} \times \textit{Safety CoRE} = \textit{Frequency} \times \textit{Safety CoRE}$$

where

- $\textit{Safety CoRE} = 1000 \times \textit{Safety Weight (50\%)} \times [\textit{Scaled Unit of the Safety Attribute}]$
- Scaled Unit of the Safety Attribute varies from 0 to 100

Consistent with the S-MAP SA, Item No. 9:

...the utility will sort its ERR risks in descending order by the Safety Risk Score. For the top 40% of ERR risks with a Safety Risk Score greater than zero, the utility will compute a Multi-Attribute Risk Score using at least the Safety, Reliability and Financial Attributes...



PG&E Selection Criteria

1. Determine ERR risks with a non-zero Safety Risk Score
2. Determine top 40% on non-zero safety risks, rounding up
3. For any risk not selected in step 2, if a risk's Safety Risk Score is within 20% of the Safety Risk Score of the lowest scored risk in step 2, add it to the list



RAMP Risk Selection

STEP 1 ↓

#	Safety Risks	Safety Risk Score	MARS	Safety CoRE	CoRE	Freq
1	Wildfire	8403	20041	19.3	46.1	434.8
2	Third Party Incident	1592	1642	0.5	0.6	2984.9
3	Motor Vehicle Incident	217	218	0.2	0.2	920.0
4	Employee Safety Incident	120	124	0.2	0.2	620.5
5	Contractor Safety Incident	116	116	0.7	0.7	159.1
6	Real Estate and Facilities Failure	104	142	0.8	1.2	123.6
7	LOC – Gas Distribution Pipeline – Non-Cross Bore	86	108	< 0.01	< 0.1	29823.8
8	Large Uncontrolled Water Release (Dam Failure)	42	71	2884.2	4850.1	0.015
9	LOC – Gas Transmission Pipeline	23	49	5.9	12.7	3.8
10	Failure of Electric Distribution Network Assets	12	12	1.1	1.1	11.0
11	Failure of Electric Distribution Overhead Assets	8	453	< 0.001	< 0.1	24311.0
12	Large Gas Overpressurization Downstream	7	8	0.9	1.0	8.3
13	Failure of Electric Distribution Underground Assets	5	Under Review	< 0.01	Under Review	2093.0
14	LOC - Customer Connected Equipment	3		< 0.0001		126436.0
15	Aviation - Helicopter Incident	3		1.2		2.5
16	LOC - Gas Storage Facilities	3		132.6		0.02
17	LOC - Distribution Pipeline - Cross Bore	2		1.0		1.7
18	Aviation Fixed Wing Incident	2		31.6		< 0.1
19	LOC - Gas M&C or C&P Facilities	2		4.6		0.3
20	Nuclear Core Damaging Event	< 0.001		2.5		< 0.001
21	LOC - CNG Station Equipment	< 0.0001		< 0.0001		14.0
22	LOC - LNG/CNG Portable Equipment	< 0.0001		< 0.0001		1.5
23	Failure of Substation Assets	< 0.0001		< 0.0001		81.5
24	Failure of Transmission Overhead Assets	< 0.0001		< 0.0001		104.1
25	Failure of Transmission Underground Assets	< 0.0001		< 0.0001		5.6
26	Hazardous Material Release	< 0.0001		< 0.0001		959.9

STEP 2

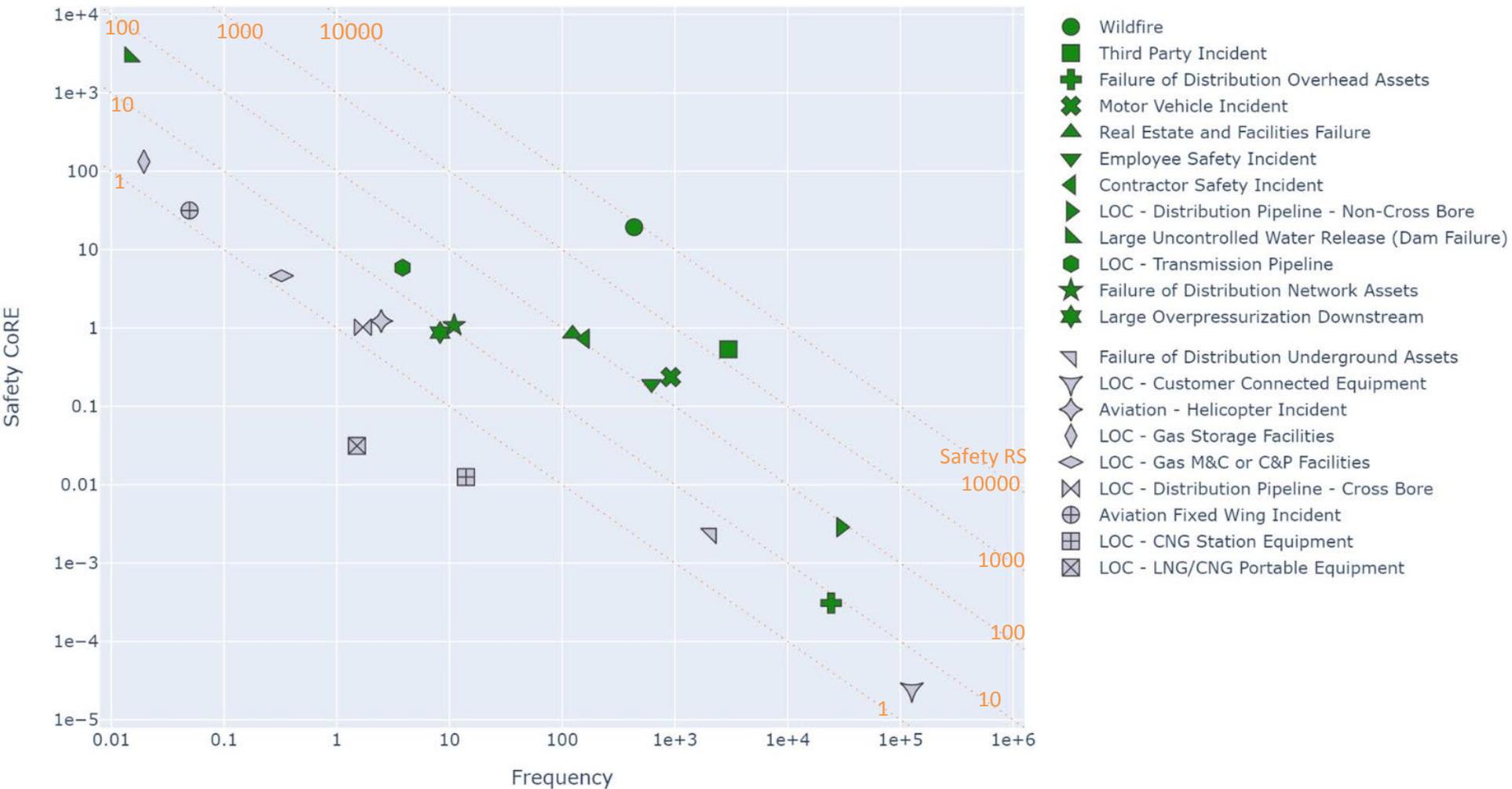
40% of 26 = 11

STEP 3

8 x 80% = 6
for safety risk score



Safety Risk Plot – Frequency vs Safety CoRE





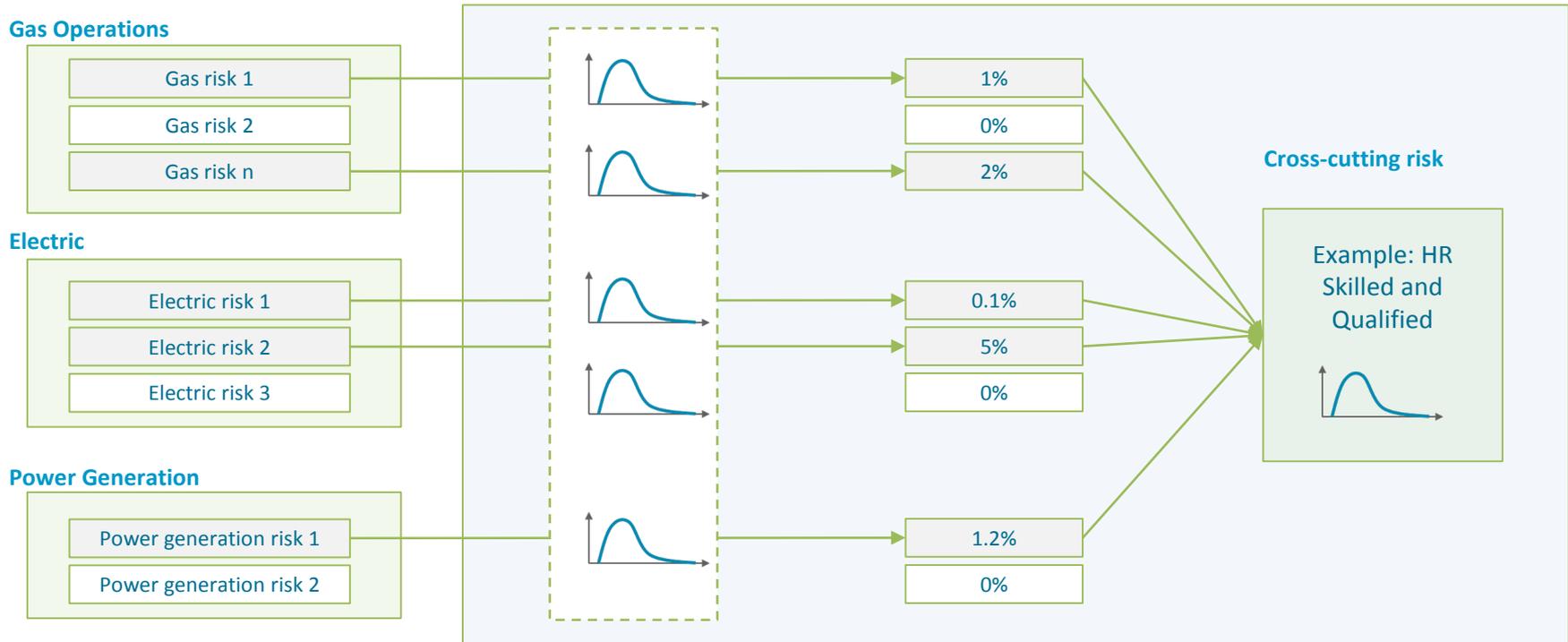
2017 RAMP Transition to 2020 RAMP

Chapter	2017 RAMP Risks	2020 Preliminary RAMP Risks
1	Transmission Pipeline Rupture with Ignition	LOC – Gas Transmission Pipeline***
3	Measurement and Control Failure – Release of Gas with Ignition Downstream	Large Gas Overpressurization Downstream***
7	Release of Gas with Ignition on Distribution Facilities – Non-Cross Bore	LOC – Gas Distribution Pipeline – Non-Cross Bore***
9	Distribution Overhead Conductor Primary	Failure of Electric Distribution Overhead Asset***
11	Wildfire	Wildfire
13	Hydro System Safety – Dams	Large Uncontrolled Water Release (Dam Failure)***
14	Contractor Safety	Contractor Safety Incident
15	Motor Vehicle Safety	Motor Vehicle Incident
16	Employee Safety	Employee Safety Incident
17	Lack of Fitness for Duty Program Awareness	Third Party Incident
18	Cyber Attack	Real Estate and Facilities Failure
19	Insider Threat	Failure of Electric Distribution Network Assets
20	Records and Information Management	2020 Cross Cutting Factors to be embedded in each RAMP Risk as applicable
21	Skilled and Qualified Workforce	
22	Climate Resilience	
2	Failure to Maintain Capacity for System Demands	2020 Risk Register, not Safety Risk Maintaining Local Capacity on High Demand
4	Measurement and Control Failure – Release of Gas with Ignition at Measurement and Control Facility	2020 Safety Risk, not shown in RAMP Loss of Containment – Gas Measurement and Control or Compression & Processing Facilities***
5	Release of Gas with Ignition on Distribution Facilities – Cross Bore	
6	Compression and Processing Failure – Release of Gas with Ignition at Manned Processing Facility	LOC – Gas Distribution Pipeline – Cross Bore***
8	Natural Gas Storage Well Failure – Loss of Containment with Ignition at Storage Facility	LOC – Gas Storage Well or Reservoir***
10	Transmission Overhead Conductor (TOHC)	Failure of Electric Transmission Overhead Asset***
12	Nuclear Core Damaging Event	Nuclear Core Damaging Event

*** Expanded Scope
 New RAMP Risk

Approach for Cross Cutting Factors in 2017 RAMP

Cross-cutting risk effects were aggregated across individual asset models.

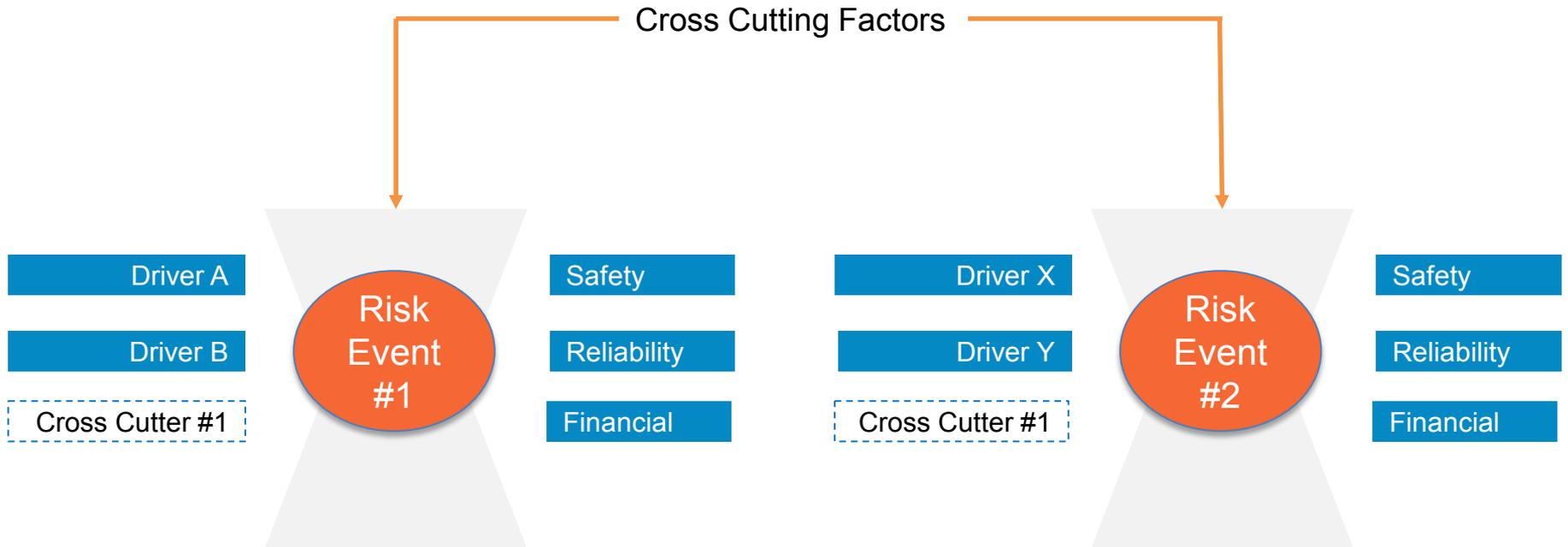




New Approach for Cross Cutting Factors in 2020 RAMP

Based on Feedback from 2017 RAMP Filing, PG&E has transitioned to Event-Based Risk Register. 50% of 2018 Company-wide Risk Register was mapped to other Event-Based Risks as factors affecting likelihood or consequence.

PG&E will model Cross Cutting Factors within the bowties of applicable Risks.





Preliminary List of RAMP Risks

LOB	Risk Event	Safety Risk Score	MARS
Power Generation (PGEN)	Large Uncontrolled Water Release (Dam Failure)	42	71
Shared Services (SS)	Real Estate and Facilities Failure	104	142
Gas Operations (GO)	LOC – Gas Distribution Pipeline – Non-Cross Bore	86	108
	LOC – Gas Transmission Pipeline	23	49
	Large Gas Over-pressurization Downstream of M&C Facility	7	8
Safety, Health, ECAP, and DOT (SHED)	Third-Party Incident	1592	1642
	Motor Vehicle Incident	217	218
	Employee Safety Incident	120	124
	Contractor Safety Incident	116	116
Electric Operations (EO)	Wildfire	8403	20041
	Failure of Electric Distribution Network Assets	12	12
	Failure of Electric Distribution Overhead Assets	8	453

2. Preliminary RAMP Risk Showing

Power Generation



Large Uncontrolled Water Release - Summary

Risk Event Summary	
Risk Definition	Given the inherent risk of owning and operating hydro assets, there is potential for a large uncontrolled water release adversely impacting the company, the public, or federal lands
Scope	In Scope: High and Significant Hazard Dams per FERC and DSOD classification Out of Scope: Low Hazard Dams, Canals, Waterways, Powerhouses, other Hydro Assets
Tranche Development	Each High and Significant Hazard Dam is its own tranche
Tranches	61 Dams
Data Range	<ul style="list-style-type: none">• Seismic driver data uses site-specific geologic data spanning millions of years• Flood and Internal Erosion driver data considers more than a century of site-specific historical experience with dams• Outcome and event data considers site-specific information and more than a century of historical experience with dams in the United States



Large Uncontrolled Water Release - Bowtie

Driver Name | Frequency | % of Risk

Total Exposure

61
DAM

Average Annual Frequency

0.015
1 in 68 years

Large
Uncontrolled
Water Release

Total Risk Score

EV | TA
71 | -

Outcome Type | % Occurrence | % Risk Safety (Injuries) Safety (Fatalities) Financial

PUB

PUB



Flood

88%

90%



Seismic

10%

7%



Internal Erosion

2%

3%



Flood

0.01291 | 88%

Seismic

0.00147 | 10%

Internal Erosion

0.00025 | 2%



Large Uncontrolled Water Release – Data Sources

Bowtie Element	Element Type	PG&E	Industry	SME
Exposure	Exposure	61 High and Significant Consequence Dams	FERC Classifications	Confirmed
Flood	Driver	PMF, Paleoflood studies	PFMA	Inspection and trending of dam assets that mitigate driver
Seismic	Driver	Site-specific analyses	FERC 2000-yr design criterion	Inspection and trending of dam assets that mitigate driver
Internal Erosion	Driver	Site-specific analyses	None	Inspection and trending of dam assets that mitigate driver
Catastrophic Dam Failure	Outcome	No internal data sources	Limited industry events	Assumed exceeding design criteria leads to failure
Financial	Consequence	Environmental damage, asset value, value of real estate, loss of generation	Net Book Value estimates determined by FERC	Identified extent of damage through Inundation zones
Safety	Consequence	Inundation zone maps	Emergency Action Plan standards set by FERC FEMA flood studies	Determined number of structures in inundation zones and assumed 1 person per structure
Reliability	Consequence	None – customers impacted would be evacuated	None available	None – customers impacted would be evacuated

Shared Services



Real Estate and Facilities Failure - Summary

Risk Event Summary

Risk Definition	Due to an unplanned event (seismic, flood, landslide, building fire, or physical security event), a building, facility or property that is deemed unsafe, or inaccessible for operation or occupancy; such that PG&E is unable to perform work and support operational needs.
Scope	In scope: Building, facilities or property owned or leased by PG&E Out of scope: Other non-facility related PG&E assets such as electric and gas transmission and distribution systems, dams, and substations. Building fire due to wildfire. These assets are covered under other risks, e.g., seismic, reliability etc.
Tranche Development	Narrowed the 3000+ active PG&E facilities to a list of recommended 50+ critical facilities for the purposes of the risk model. For the seismic review, the model is a pilot based on a qualitative sample of 15 buildings (3 high earthquake outside the bay area and 12 in the bay area--with input from previous structural studies) and three deep dive studies. Ongoing seismic review would include sampling and reviewing sites within high seismic zones.
Tranches	Critical facility examples include data centers, emergency centers, telecom hubs, contact centers etc. Seismic screening for facilities included reviewing high rise buildings, multi-story buildings greater than 4 stories, and buildings less than 4 stories
Data Range	Seismic data: Recent studies of three sites in October 2019, modeling data of 15 sites as of November 2019. (Analysis includes data input of ground motion recordings from the last 50 years as well as historical geological information.) Flood data: Current and historical and current GIS flood data. Landslide data: within the last thirty years. Physical Attack data: 2016-2018. Fire data: within the last 20 years.



Real Estate and Facilities Failure - Bowtie

Driver Name | Frequency | % of Risk

Physical Security 72.865 | 59%

Seismic 50 | 40%

Building Fire 0.59099 | <1%

Flood 0.116 | <1%

Landslide 0.01 | <1%

Total Exposure
50
CRITICAL FACILITIES

Average Annual Frequency
123.582
124 per year

Real Estate and
Facilities
Failure

Total Risk Score
EV | TA
142.23 | -

Outcome Type | % Occurrence | % Risk Safety (Injuries) Safety (Fatalities) Financial

Outcome Type	% Occurrence	% Risk	Safety (Injuries) EMPL	Safety (Fatalities) EMPL	Financial
< Seismic 0.05-0.20g Minor	3%	37%	✓	✓	✓
< Seismic 0.20-0.40g Moderate	<1%	30%	✓	✓	✓
< Seismic >0.6g Severe	<1%	17%	✓	✓	✓
< Seismic 0.40-0.60g Strong	<1%	16%	✓	✓	✓
< Non-Structural	60%	-			✓
< Seismic 0-0.05g Insignificant	37%	-	✓	✓	✓



Real Estate and Facilities Failure – Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	FM:Interact (FMI)		
Physical Security	Driver	PG&E Corporate Security Database (ECTS)		
Seismic	Driver	PG&E Facility records	USGS seismic studies HB-Risk Group (FEMA P-58)	PG&E Geosciences
Building Fire	Driver			Subject matter expert knowledge
Flood	Driver		FEMA GIS Flood Zone Data	
Landslide	Driver			PG&E Meteorology Department Data
Outcomes	Outcome		HB-Risk Group (FEMA P-58)	PG&E Geosciences
Financial Consequence	Consequence	PG&E project-based rebuild cost data	Average total cost to rebuild structure	Data modified based on type of building and geographical area.
Safety Consequence	Consequence	FM:Interact (FMI)		Based on PG&E occupancy analysis

Gas Operations





LOC – Gas Distribution Pipeline Non-Cross Bore - Summary

Risk Event Summary

Risk Definition	Failure of a distribution pipeline resulting in loss of containment and/or uncontrolled gas flow that can lead to significant impact on public, employee, and/or contractor safety, property damages, financial losses, and/or the inability to deliver natural gas to customers.
Scope	In scope: Failure of a distribution pipeline that leads to a significant loss of containment (leak or rupture). Out of scope: A loss of containment driven by Large Over-pressurization (OP) Events (included in “Large OP Event” risk model) or a cross bore (included in “LOC – Distribution Cross Bore Event” risk model), and customer connected equipment (included in “Loss of Containment on Customer Connected Equipment” risk model)
Tranche Development	Each tranche represents a grouping of distribution pipeline assets that have a homogenous risk profile for all loss of containment events. Assets were trached by both the likelihood of failure (material type) and the consequence of failure (asset type). Dividing up the pipeline assets based on this analysis resulted in five tranches, each with a unique combination of the likelihood of a LOC and the consequences of a LOC.
Tranches	The tranches are: (1) Risers, (2) Main – Steel Pipe, (3) Services – Steel Pipe, (4) Main – Plastic Pipe, and (5) Services – Plastic Pipe.
Data Range	RiskFinder System and PHMSA from 2010 - 2019



LOC – Gas Distribution Pipeline Non-Cross Bore - Bowtie

Driver Name | Frequency | % of Risk

Equipment Failure 18844 | 63%

Corrosion 3234.77778 | 11%

Incorrect Operation 3049.55556 | 10%

Excavation Damage 1771.44444 | 6%

Material Failure of Pipe or Weld 1340.33333 | 4%

Other 1164 | 4%

Natural Force Damage 227.77778 | <1%

Other Outside Force Damage 191.88889 | <1%

Total Exposure
7,011,720.25
EQUIPMENT

Average Annual Frequency
29823.778
29824 per year

Loss of
Containment -
Distribution
Facilities - Non-
Cross Bore

Total Risk Score
EV | TA
108.78 | -

Outcome Type | % Occurrence | % Risk

Safety (Injuries)

Safety (Fatalities)

Reliability

Financial

PUB

EMPL

CONT

PUB

EMPL

CONT

GAS



LoC

100%

100%





LOC – Gas Distribution Pipeline Non-Cross Bore – Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	Miles of PG&E distribution main pipeline Number of PG&E services Number of PG&E risers		
All Drivers (All Loss of Containment (LOC) Events)	Driver	PG&E leak data from RiskFinder System		
Loss of Containment	Outcome	PG&E incidents reported to PHMSA		
Financial	Consequence	Leak Repairs – PG&E GRC Unit Cost	PHMSA data: reportable incidents	
Safety	Consequence	PG&E incidents reported to PHMSA		
Reliability Gas	Consequence	PG&E Gas Reliability Data		



LOC – Gas Transmission Pipeline - Summary

Risk Event Summary

Risk Definition	Failure of a transmission pipeline resulting in a loss of containment and/or uncontrolled gas flow that can lead to significant impact on public, employee, and/or contractor safety, property damages, financial losses, and/or the inability to deliver natural gas to customers.
Scope	In scope: Failure of a transmission pipeline that leads to a significant loss of containment (leak or rupture). Out of scope: A loss of containment driven by Large Over-pressurization (OP) Events (included in “Large OP Event” risk model).
Tranche Development	Each tranche represents a grouping of transmission pipeline assets that have a homogenous risk profile for leak and rupture loss of containment events. Assets were trached by both the likelihood of failure (pipe versus non-pipe, % Specified Minimum Yield Strength (SMYS)) and the consequence of failure (High Consequence Area (HCA) versus non-HCA). Dividing up the pipeline assets based on this analysis resulted in four tranches, each with an unique combination of likelihood of a LOC and the consequences of a LOC.
Tranches	The tranches are: (1) $\geq 20\%$ SMYS in HCA, (2) $\geq 20\%$ SMYS in Non-HCA, (3) $< 20\%$ SMYS, and (4) Non-Pipe
Data Range	PHMSA from 2001- 2018



LOC – Gas Transmission Pipeline– Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	Miles of PG&E transmission pipeline		
All Drivers (All Loss of Containment (LOC) Events)	Driver	PG&E frequency data, when available (PHMSA – PG&E)	PHMSA frequency data when PG&E data is unavailable	
Leak Probability	Outcome	Derived from the sum of all leak driver frequencies		
Rupture Probability	Outcome	Derived from the sum of all rupture driver frequencies		
Financial	Consequence		PHMSA	
Safety	Consequence		PHMSA	
Reliability	Consequence	PG&E Gas Reliability Data		



Large Gas Over-pressurization Downstream of M&C Facility- Summary

Risk Event Summary

Risk Definition	A large overpressurization (OP) event occurring downstream of an M&C facility may impact downstream pipe assets and can lead to significant impact on public, employee, and/or contractor safety, property damages, financial losses, and/or the inability to deliver natural gas to customers.
Scope	In-scope: Large OP Events Out-of-scope: Small OP Events
Tranche Development	Each tranche represents a group of M&C stations that are considered to have a homogeneous risk profile associated with overpressure events. Stations were trached through an assessment of the likelihood of station equipment resulting in a large OP event as well as the potential consequences downstream, should a large OP event occur. This assessment resulted in seven tranches, each with a unique combination of potential likelihood and consequence profiles associated with large OP events.
Tranches	The tranches evaluated by the risk model are: (1) Distribution District Regulator Stations, (2) Distribution Low Pressure Regulator Stations, (3) Distribution Farm Taps, (4) Transmission Large Volume Customer Regulator (LVCR) Sets, (5) Distribution High Pressure Regulator Stations, (6) Transmission Complex Stations, and (7) Transmission Simple Stations.
Data Range	PHMSA from 2010- 2019, PG&E OP Data 2010-2019

* An OP event occurs when the gas pressure exceeds the maximum allowable operating pressure (MAOP) of the pipeline and are defined by CPUC/DOT requirements. The established pressure limits for large OP events are:

- High pressure gas distribution (MAOP 1 psig to 12 psig): greater than 50% above MAOP
- High pressure gas distribution (MAOP 12 psig to 60 psig): greater than 6 psig
- Low pressure gas distribution: over 16 inches water-column
- Transmission pipelines: greater than 10% above MAOP (or >25 psig on pipelines operating over 250 psig)

OP events that exceed MAOP but do not exceed the limits above are categorized as small OP events, which are out-of-scope for this risk.



Large Gas Over-pressurization Downstream of M&C Facility- Bowtie

Driver Name | Frequency | % of Risk

Equipment Related 6 | 73%

Incorrect Operations 2.3 | 27%

Total Exposure

4,624
STATIONS

Average Annual Frequency

8.253
8 per year

Large Gas
Over-
pressurization
Downstream
of M&C Facility

Total Risk Score

EV | TA
8.05 | -

Outcome Type | % Occurrence | % Risk

Safety (Injuries)

Safety (Fatalities)

Reliability

Financial

PUB EMPL CONT

PUB EMPL CONT

GAS

< LOC 5% 98%

✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓

< Benign 95% 2%

✓



Large Gas Over-pressurization Downstream of M&C Facility— Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	Count of PG&E stations		
Incorrect Operations	Driver	Count of PG&E large OP events attributed to incorporate operations		
Equipment-Related	Driver	Count of PG&E large OP events attributed to equipment-related causes		
Benign OP	Outcome	Count of PG&E large OP events: proportion of benign events		
Financial	Consequence			PG&E Financial Estimates
OP event resulting in LOC	Outcome	Count of PG&E large OP events: proportion of events resulting in LOC		
Financial	Consequence		PHMSA data: reportable incidents	
Safety	Consequence		PHMSA data: reportable incidents	
Reliability Gas	Consequence	PG&E Gas Reliability Data		

Safety, Health, ECAP, and DOT



Third Party Incident - Summary

Risk Event Summary

Risk Definition	Any recordable injury or fatality to a third party due to interaction with or during the use of a PG&E facility, not involving asset failure.
Scope	In Scope: Recordable third-party injuries or fatalities due to interaction with or during the use of a PG&E facility, not involving asset failure. Out of Scope: Third party recordable injuries or fatalities resulting from the failure of an asset. Third party gas dig-in recordable injuries or fatalities are included as key drivers for Gas Operations Loss of Containment risks.
Tranche Development	Third party recordable injuries and fatalities post Line of Business data review and analysis.
Tranches	Public Interaction with Electric Operations Assets and Job Sites Public Interaction with Gas Operations Assets and Job Sites (non dig-ins) Public Interaction with Power Generation PG&E Managed Land and Water Interaction with Generation Assets
Data Range	2012 through June 2019



Third Party Incident - Bowtie

Driver Name | Frequency | % of Risk

Car Pole/Guy 1710 | 57%

Electric Contact 1234.8 | 41%

Others 30.9 | 1%

Job Site 2.6 | <1%

Drowning or Other Incidents in PG&E Managed/ Owned Property 2.5 | <1%

Slip / Trip / Fall 2.3 | <1%

Suicide 1.7 | <1%

Falling Object/Vegetation 0.15385 | <1%

Motor Vehicle Incident (Non-Pole Related)

Total Exposure
4
SYSTEM TERRORITY

Average Annual Frequency
2984.892
2985 per year

3rd Party Safety Incident

Total Risk Score
EV | TA
1641.4 | -

Outcome Type | % Occurrence | % Risk Safety (Injuries) Safety (Fatalities) Reliability

PUB

PUB

ELEC

< Public Interaction 100% 100%





Third Party Incident– Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	PG&E Service Territory		
Car Pole/Guy	Driver	3 rd Party Initiated incidents logged in Integrated Logging Information System (ILIS)		
Electric Contact	Driver	3 rd Party Initiated incidents logged in Integrated Logging Information System (ILIS)		
Other	Driver	Serious Incidents Report / Electric Incidents Report		
Job Site	Driver	Serious Incidents Report / Electric Incidents Report		
Drowning or Other Incidents	Driver	Serious Incidents Report / Electric Incidents Report		
Slip/Trip/Fall	Driver	Serious Incidents Report / Electric Incidents Report		
Suicide	Driver	Serious Incidents Report / Electric Incidents Report		
Falling Object / Vegetation	Driver	Serious Incidents Report / Electric Incidents Report		
Motor Vehicle Incident (non-pole)	Driver	Serious Incidents Report / Electric Incidents Report		
Safety	Consequence	Serious Incidents Report / Electric Incidents Report		
Reliability	Consequence	Electric Operations Customer Outage Report		



Motor Vehicle Incident - Summary

Risk Event Summary

Risk Definition	Any motor vehicle accident involving a PG&E vehicle (or one operated on behalf of PG&E) resulting in recordable injuries or fatalities for employees or the public, property damage, and other consequences.
Scope	In Scope: Any recordable motor vehicle incident involving a PG&E vehicle (or one operated on behalf of PG&E) Out of Scope: Motorized equipment, off-road vehicles, off-road driving, unique or specialized vehicles, non-staff augmentation contractors, and other drivers.
Tranche Development	Reviewed PG&E motor vehicle incident data to determine tranches for PG&E owned vehicle weight classes and vehicle types.
Tranches	PG&E owned - Trucks less than 10,000 lbs. PG&E owned - Trucks 10,000 - 26,000 lbs. PG&E owned - Trucks greater than 26,000 lbs. PG&E owned - Passenger vehicles PG&E owned - Trailers PG&E owned - Carpool Vans Employee owned vehicles Rental vehicles
Data Range	2016 through July 2019



Motor Vehicle Incident - Bowtie

Driver Name | Frequency | % of Risk

Non-Preventable (NPMVI) 518.3 | 56%

PMVI - PG&E Hit Stationary Object 110.3 | 12%

PMVI - PG&E Backing 98.3 | 11%

PMVI - PG&E Struck 3rd party 79.4 | 9%

PMVI - PG&E Rear Ended 3rd Party 65.1 | 7%

PMVI - PG&E Initiated (All Other) 36.6 | 4%

PMVI - PG&E Hit PG&E Equipment 12 | 1%

Total Exposure
140.92
MILLION MILES

Average Annual Frequency
920
920 per year

Motor Vehicle
Safety Incident

Total Risk Score
EV | TA
218.21 | -

Outcome Type | % Occurrence | % Risk | Safety (Injuries) | Safety (Fatalities) | Financial

PUB EMPL PUB EMPL

< Non-Preventable Motor Vehicle Incident	56%	56%	✓	✓	✓	✓	✓
< Preventable Motor Vehicle Incident	44%	44%	✓	✓	✓	✓	✓



Motor Vehicle Incident– Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	Fleet Data		
Non-Preventable	Driver	Motor Vehicle Incident Data		
Hit Stationary Object	Driver	Motor Vehicle Incident Data		
Backing	Driver	Motor Vehicle Incident Data		
Struck 3 rd party	Driver	Motor Vehicle Incident Data		
Rear Ended 3 rd party	Driver	Motor Vehicle Incident Data		
All Other	Driver	Motor Vehicle Incident Data		
Hit PG&E Equipment	Driver	Motor Vehicle Incident Data		
Outcome	Outcome	Motor Vehicle Incident Data		
Financial	Consequence	GRC / SEMS Database		
Safety	Consequence	Serious Injuries report		



Employee Safety Incident - Summary

Risk Event Summary

Risk Definition	Any event resulting in an employee recordable injury or fatality, excluding events resulting from asset failure.
Scope	In Scope: PG&E employee recordable injuries and fatalities that are not the result of an asset failure Out of Scope: PG&E employee recordable injuries and fatalities resulting from the failure of an asset.
Tranche Development	PG&E employee recordable injuries and fatalities data review to determine the feasibility of tranches for office based and field personnel.
Tranches	PG&E office-based employees PG&E field employees
Data Range	2008 through Oct. 2019



Employee Safety Incident - Bowtie

Driver Name | Frequency | % of Risk

26 - Bodily reaction and exertion, unspecified	112.08127 18%
32 - Typing or keyentry or mousing	59.15157 10%
25 - Strain in twisting/turning	48.02231 8%
28 - Strain in lifting/lowering	41.01176 7%
21 - Fall to floor, walkway, or other surface on same level	34.96515 6%
30 - Repetitive placing, grasping, moving objects, except tools	33.91357 5%
31 - Repetitive use of tools	29.33197 5%
29 - Strain in pulling or pushing	26.99064 4%
3 - Contact with objects and equipment	24.88748 4%
27 - Overexertion in holding, carrying, turning, or wie	24.36168 4%
14 - Contact with skin or other exposed tissue	23.83589 4%
15 - Exposure to noise	23.13484 4%
23 - Slip, trip, loss of balance -- without fall	21.64509 3%
35 - Venomous bites, stings, injections	11.91795 2%

Total Exposure
22,265
WORKFORCE

Average Annual Frequency
620.522
621 per year

Employee
Safety Incident

Total Risk Score
EV | ITA
124.39 | -

Outcome Type | % Occurrence | % Risk Safety (Injuries) Safety (Fatalities) Financial

			EMPL	EMPL		
<	Overexertion and bodily reaction	60%	55%	✓	✓	✓
<	Contact with object or equipment	14%	16%	✓	✓	✓
<	Falls slips trips	12%	12%	✓	✓	✓
<	Exposure to harmful substances or environments	9%	10%	✓	✓	✓
<	Violence and other injuries by persons or animal	4%	4%	✓	✓	✓
<	All Other	<1%	<1%	✓	✓	✓
<	Fires explosions	<1%	<1%	✓	✓	✓



Employee Safety Incident– Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	PG&E Human Resources report		
Event Causes (Drivers)	Driver	PG&E Cal/OSHA recordable data by claim cause		
All Outcomes (by type)	Outcome	PG&E Cal/OSHA recordable data by claim cause category		
Financial	Consequence	GRC, PG&E SEMS database		
Safety	Consequence	PG&E serious designated employee injuries (Cal/OSHA definition) and fatalities		



Contractor Safety Incident - Summary

Risk Event Summary

Risk Definition	Any event resulting in a contractor recordable injury or fatality, excluding events resulting from asset failure.
Scope	In Scope: PG&E contractor recordable injuries and fatalities that are not the result of an asset failure Out of Scope: PG&E contractor recordable injuries and fatalities resulting from the failure of an asset.
Tranche Development	Review of available contractor safety data.
Tranches	PG&E contractors performing medium and high-risk work activities in alignment with the Contractor Safety Program
Data Range	2017 through Oct. 2019 (ISNetworld)



Contractor Safety Incident - Bowtie

Driver Name | Frequency | % of Risk

Other	58.71775	37%
Sprains, strains, tears	28.97257	18%
Cuts and lacerations	22.01916	14%
Bruises and contusions	15.83834	10%
Fractures	13.43013	8%
Abrasions, scratches	6.95342	4%
Back pain, hurt back	6.56712	4%
Animal or insect bites	3.86301	2%
Punctures, except bites	2.70411	2%

Total Exposure
24,843
CONTRACT EMPLOYEE COUNT

Average Annual Frequency
159.066
159 per year



Total Risk Score
EV | TA
116.14 | -

Outcome Type | % Occurrence | % Risk | Safety (Injuries) | Safety (Fatalities)

			CONT	CONT
< Serious Injury or Fatality	2%	100%	✓	✓
< OSHA Recordable	98%	-	✓	✓



Contractor Safety Incident– Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	ISNetwork		
PG&E contractor incidents by injury type	Drivers	ISNetwork		
Safety	Consequence	PG&E Serious Incidents report		

Electric Operations





Wildfire - Summary

Risk Event Summary

Risk Definition	PG&E assets or activities may initiate a fire that is not easily contained, endangers the public, private property, sensitive lands or environment.
Scope	In Scope: PG&E Assets or activities resulting in an ignition (PG&E CPUC Reportable Ignitions) Out of Scope: Non PG&E Assets or activities resulting in an ignition
Tranche Development	Whether Ignition took place in HFTD or a non-HFTD area (2 possible tranches) Whether Ignition is associated with an transmission, distribution, or substation outage (3 possible tranches) In total, there are currently 6 possible tranches (2 x 3)
Tranches	<ul style="list-style-type: none">• HFTD – Distribution• HFTD – Transmission• HFTD – Substation• Non-HFTD – Distribution• Non-HFTD – Transmission• Non-HFTD – Substation
Data Range	CPUC Reportable Ignitions from January 1, 2015 to December 31st, 2018



Wildfire - Bowtie

Driver Name | Frequency | % of Risk

Total Exposure
98,965
MILES

Average Annual Frequency*
434.75
435 per year



Total Risk Score
EV | TA
20040.67 | -

Equip Failure	167.5 39%
Vegetation	109.5 25%
3rd Party	82.7 19%
Animal	49.3 11%
Unk or Other	25.8 6%

Outcome Type | % Occurrence | % Risk Safety (Injuries) Safety (Fatalities) Reliability Financial

Outcome Type	% Occurrence	% Risk	Safety (Injuries)	Safety (Fatalities)	Reliability	Financial
Fire Weather Warning - Catastrophic Fires	<1%	78%	✓	✓	✓	✓
Non-Fire Weather Warning - Catastrophic Fires	<1%	16%	✓	✓	✓	✓
Non-Fire Weather Warning - Destructive Fires	<1%	5%			✓	✓
Fire Weather Warning - Destructive Fires	<1%	<1%			✓	✓
Non-Fire Weather Warning - Small Fires	94%	<1%	✓	✓	✓	✓
Non-Fire Weather Warning - Large Fires	<1%	<1%	✓	✓	✓	✓
Fire Weather Warning - Large Fires	<1%	<1%	✓	✓	✓	✓
Fire Weather Warning - Small Fires	4%	<1%	✓	✓	✓	✓

*Average annual frequency reflects the number annual CPUC reportable ignitions



Wildfire – Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	GIS		
Vegetation	Driver	CPUC reportable Ignitions and known fires associated outage		
Equipment failure	Driver	CPUC reportable Ignitions and known fires associated outage		
Third party	Driver	CPUC reportable Ignitions and known fires associated outage		
Animal	Driver	CPUC reportable Ignitions and known fires associated outage		
Fire Weather Warning – Catastrophic Fire	Outcome		CALFIRE, NWS	
Fire Weather Warning – Destructive Fire	Outcome		CALFIRE, NWS	
Fire Weather Warning – Large Fire	Outcome		CALFIRE, NWS	
Fire Weather Warning – Small Fire	Outcome	PG&E CPUC reportable Ignitions		
Non-Fire Weather Warning – Catastrophic Fire	Outcome		CALFIRE, NWS	
Non-Fire Weather Warning – Destructive Fire	Outcome		CALFIRE, NWS	
Non-Fire Weather Warning – Large Fire	Outcome		CALFIRE, NWS	
Non-Fire Weather Warning – Small Fire	Outcome	PG&E CPUC reportable Ignitions		
Safety	Consequence		CALFIRE	
Reliability	Consequence	ILIS and TOTL		
Financial	Consequence		CALFIRE	



Failure of Distribution Network Assets - Summary

Risk Event Summary	
Risk Definition	Failure of distribution network assets or lack of remote operation functionality may result in public or employee safety issues, property damage, environmental damage or inability to deliver energy.
Scope	In Scope: Failure of assets associated with urban underground electrical distribution networks (downtown SF and Oakland) including Network transformers, Network cables, Network protectors, Primary and secondary Out of Scope: Failure of assets associated with Non-network underground and overhead distribution, Underground transmission cables
Tranche Development	Distribution network asset replacement strategy with the list of underground network circuits broken down along the following lines: <ul style="list-style-type: none">• Circuits prioritized for replacement based on failures and cable testing (Tranche: Circuits with high failure rate)• Circuits with old vintage cables replaced by YE 2019 (Tranche: Reconductored Circuits)• Circuits with newer EPR (ethylene propylene rubber) vintage cable type. (Tranche: All Other circuits)
Tranches	<ul style="list-style-type: none">• Circuits with high failure rate• Reconductored circuits• All other circuits
Data Range	<ul style="list-style-type: none">• Event: Failure data from February 2008 through October 2018• Outcome: Electric Incident Report from February 2014 through May 2019 (Safety)



Failure of Distribution Network Assets - Bowtie

Driver Name | Frequency | % of Risk

Underground Network Equipment Failure 8.9 | 81%

Human Performance 2.1 | 19%

Natural Hazards

Sabotage / Terrorism

Total Exposure

188
MILES

Average Annual Frequency

11.002
11 per year

Failure of
Distribution
Network Assets

Total Risk Score

EV | TA
12.26 | -

Outcome Type | % Occurrence | % Risk Safety (Injuries) Safety (Fatalities) Reliability Financial

PUB

PUB

ELEC

< Asset Failure / Associated with Catastrophic Failure 17% 97%



< Asset Failure / Not associated with Catastrophic Failure 71% 3%



< Asset Failure - Human Induced / Not associated with Catastrophic Failure 12% <1%





Failure of Distribution Network Assets – Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	SME Input		
Underground Network Equipment Failure	Driver	Distribution Underground Network Failure Dataset		
Human Performance	Driver	Distribution Underground Network Failure Dataset		
Natural Hazard	Driver	Distribution Underground Network Failure Dataset		
Sabotage / Terrorism	Driver	Distribution Underground Network Failure Dataset		
Asset Failure / Not associated with Catastrophic Failure	Outcome	Distribution Underground Network Failure Dataset		
Asset Failure / Associated with Catastrophic Failure	Outcome	Distribution Underground Network Failure Dataset		
Asset Failure - Human Induced / Not associated with Catastrophic Failure	Outcome	Distribution Underground Network Failure Dataset		
Safety	Consequence	EIR		SME Input
Reliability	Consequence			SME Input
Financial	Consequence	Distribution Underground Restoration Costs Dataset		



Failure of Distribution Overhead Assets - Summary

Risk Event Summary	
Risk Definition	Failure of distribution overhead assets or lack of remote operation functionality may result in public or employee safety issues, property damage, environmental damage or inability to deliver energy.
Scope	<p>In Scope: Failure of assets associated with overhead electrical distribution system including Pole/ Support Structure, Primary Conductor, Voltage Regulating Equipment, Protection Equipment, Switching Equipment, Transformers and Secondary Conductor. Includes PG&E owned Streetlights.</p> <p>Out of Scope: Consequences of ignitions associated with the failure of assets in scope (In scope of the Wildfire Risk)</p>
Tranche Development	<p>Tranching was determined on whether the asset failure occurred on a circuit with a high or low likelihood of failure as determined by a Distribution Overhead Prioritization Model. Model determined outage likelihood based on a random forest regression analysis predicting failures at the circuit level. The model tested over 1,000 variables and was able to capture the top ten most important variables when analyzing distribution circuits. The variables can be broken into 8 category characteristics including: Conductor, Transformer, Fuse, Protective Device, Switch, Pole, Capacitor bank, Notification</p> <p>The model was used to bifurcate PG&E circuits into two tranches – Circuits with a High Likelihood of Failure [$\text{Pr}(\text{failure}) > 50\%$] and Circuits with a Low Likelihood of Failure [$\text{Pr}(\text{failure}) < 50\%$]</p>
Tranches	<ul style="list-style-type: none">• Circuits w/ Low Likelihood of Failure resulting in an Outage (Probability of failure < 50%) based on Random Forest regression model• Circuits w/ High Likelihood of Failure resulting in an Outage (Probability of failure > 50%) based on Random Forest regression model
Data Range	<ul style="list-style-type: none">• Outages from January 1st, 2014 through December 31st, 2018.• Outcome: Electric Incident Report from February 2014 through May 2019 (Safety) – 2017 Outage Restoration Costs (Financial).



Failure of Distribution Overhead Assets - Bowtie

Driver Name | Frequency | % of Risk

Other 7160.9 | 29%

D-Line Equipment Failure 5765.7 | 24%

Vegetation 4588.3 | 19%

Other PG&E Assets or Processes 3377.1 | 14%

Animal 2128.9 | 9%

Natural Hazard 1059.5 | 4%

PG&E Activity 151.9 | <1%

Human Performance 41.6 | <1%

Customer Equipment Failure 37 | <1%

Total Exposure
81,082
MILES

Average Annual Frequency
24311.04
24311 per year

Failure of
Distribution
Overhead
Assets

Total Risk Score
EV | TA
453.42 | -

Outcome Type | % Occurrence | % Risk | Safety (Injuries) | Reliability | Financial

PUB | EMPL | ELEC

< Asset Failure / Not associated with Ignition 98% 99% ✓ ✓ ✓ ✓

< Asset Failure - Human Induced / Not associated with Ignition <1% <1% ✓ ✓



Failure of Distribution Overhead Assets – Data Sources

Bowtie Element	Element Type	PG&E Data Source	Industry Source	SME Source
Exposure	Exposure	GIS		
Other	Driver	Distribution Overhead Outage Dataset		
D-Line equipment failure	Driver	Distribution Overhead Outage Dataset		
Vegetation	Driver	Distribution Overhead Outage Dataset		
Other PG&E assets or processes	Driver	Distribution Overhead Outage Dataset		
Animal	Driver	Distribution Overhead Outage Dataset		
Natural Hazard	Driver	Distribution Overhead Outage Dataset		
PG&E activity	Driver	Distribution Overhead Outage Dataset		
Human Performance	Driver	Distribution Overhead Outage Dataset		
Customer Equipment Failure	Driver	Distribution Overhead Outage Dataset		
Asset Failure / Not associated with Ignition	Outcome	Distribution Overhead Outage Dataset, Ignition Tracker Dataset		
Asset Failure / Associated with Ignition	Outcome	Distribution Overhead Outage Dataset, Ignition Tracker Dataset		
Asset Failure - Human Induced / Not associated with Ignition	Outcome	Distribution Overhead Outage Dataset, Ignition Tracker Dataset		
Safety	Consequence	EIR		
Reliability	Consequence	Distribution Overhead Outage Dataset		
Financial	Consequence	Distribution Overhead Restoration Costs Dataset		

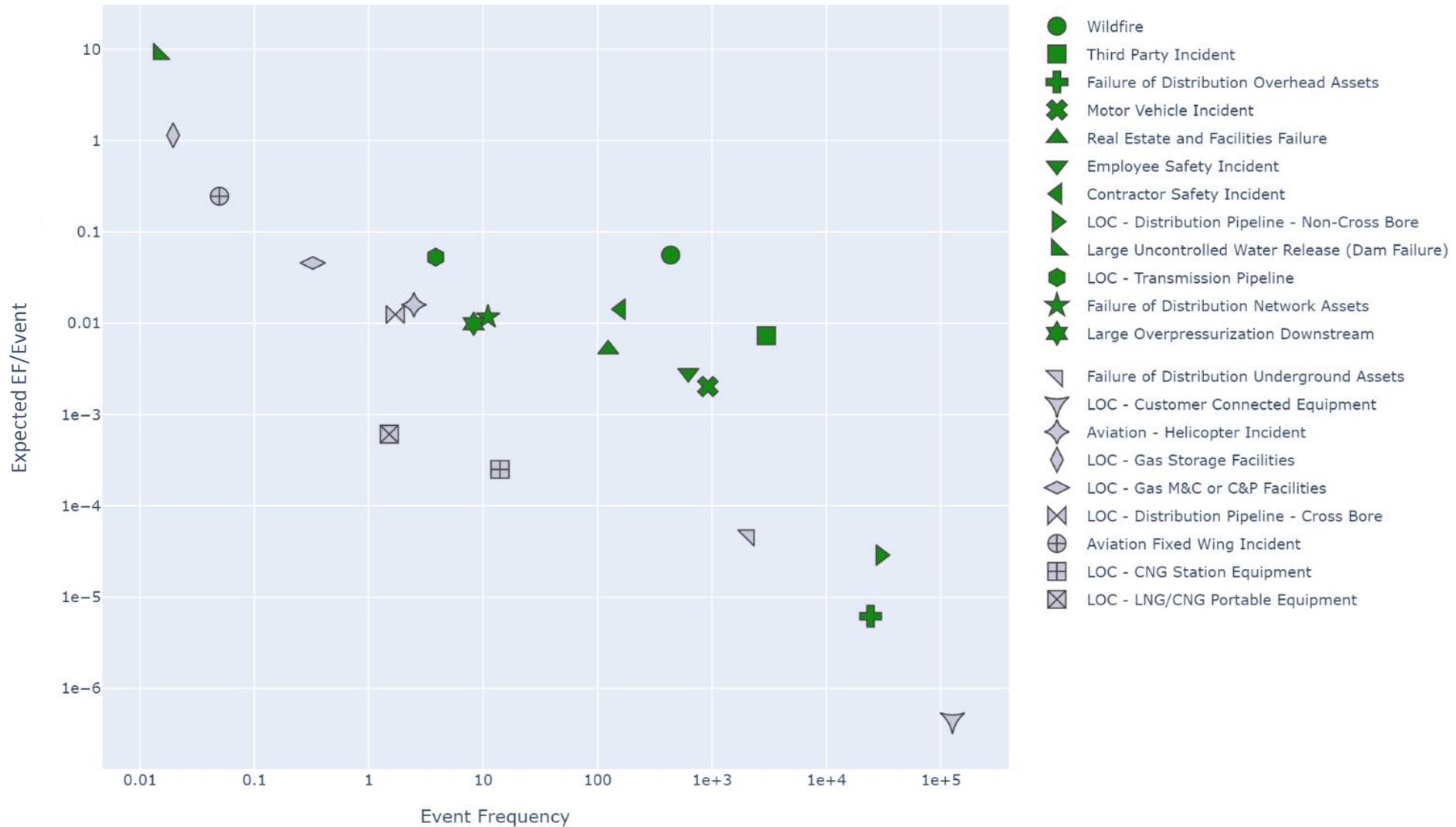


Appendix





Safety Risk Plot – Frequency vs Safety Natural Unit





Cross-Cutting Factors being Considered

#	Cross Cutting Factors
1	Climate Resilience
2	Seismic
3	Skilled and Qualified Workforce
4	Records and Information Management
5	IT Asset Failure
6	Cyber Threat
7	Physical Threat
8	Emergency Preparedness and Response
9	Contract Management
10	Third Party Risk Management

Cross Cuttings Factors impact to Safety Risks will be evaluated on a risk by risk basis.



Data Source Descriptions Part 1

Data Source	Description
FERC	Federal Energy Regulatory Commission
PFMA	Potential Failure Mode Analysis
PMF	Probable Maximum Flood – site-specific analysis mandated by the FERC
HB-Risk Group (FEMA P-58)	Risk analysis method which uses generic fragility data from historical events/analysis
FEMA GIS Data	Federal Emergency Management Agency Geographic Information System Mapping (GIS) flood zone data
FM:Interact (FMI)	PG&E database housing number of seated employees per facility
Enterprise Compliance Tracking System (ECTS)	PG&E Corporate Security Database showing crimes against PG&E property for 2016-2018. Types of incidents include, e.g., intruder, theft, vandalism etc.
USGS	United States Geological Services seismic studies
PG&E Geosciences	Internal study of three sites in October 2019, modeling data of 15 sites as of November 2019.
RiskFinder System (2010 - 2019)	The Distribution Integrity Management Program (DIMP) RiskFinder System tracks leaks on PG&E distribution mains and services and includes Pipeline and Hazardous Materials Safety Administration (PHMSA) reportable and non-reportable leaks.
GRC Unit Cost (2020)	2020 General Rate Case (GRC)
PHMSA Database (2010 - 2019) NonCB	PHMSA Significant Incident data
PG&E Gas Reliability Data (2015 -2016 to be updated beyond 2016 in final model)	Number of distribution customers impacted per gas outage
PHMSA – PG&E (2001 to 2018) TIMP	Major PG&E incidents reported to Pipeline and Hazardous Materials Safety Administration (PHMSA)
PHMSA – Industry (2001 to 2018) TIMP	PHMSA Significant Incident data
PG&E Gas Reliability Data (2017)	Customer outage data from "Consolidated_Radial_System.xls" provided by Gas Planning Department
PG&E Large OP Data (2011 to 2018)	PG&E's MOP Excursion Master File
PHMSA Database (2010 to 2018) Large OP	Pipeline and Hazardous Materials Safety Administration (PHMSA) Major Incident data



Data Source Descriptions Part 2

Data Source	Description
Serious Incidents Report	PG&E Serious designated employee injuries (Cal/OSHA definition) and fatalities and PG&E recordable third-party injuries and fatalities
Motor Vehicle Incident Report	PG&E HCMS motor vehicle incident report. Motor vehicle incident (MVI) data recorded (2016 through July 2019)
Fleet Data	Fleet vehicle and mileage data records (2016 through July 2019)
PG&E SEMS database	Cal/OSHA employee recordables including Days Away, Restricted or Transferred (DART) Cases (2016 through Oct. 2019)
GRC	PG&E 2020 General Rate Case Chapter 1A Integrated Disability Management. Average cost per workers compensation claim (2014 through 2017 claim year)
PG&E SEMS database	Cal/OSHA recordables including Days Away, Restricted or Transferred (DART) Cases (2008 through May 2019)
PG&E Human Resources report	Personnel information for number of field and office employees (tranches)
ISNetwork - Contractor Safety Third Party Administrator	Site tracker report for PG&E contractor hours PG&E contractor incidents by injury type
GIS	PG&E asset mapping data
CPUC reportable Ignitions	Reportable CPUC ignitions extracted from Ignition tracker dataset (Ignition tracker logs ignition incidents caused by PG&E assets)
CALFIRE	Fires incidents in PG&E territory published by California department of forestry and fire protection
NWS	Fire weather warning shapefiles provided by National Weather Service (NWS)
ILIS	Integrated Logging Information System (ILIS) which logs distribution outage incidents.
TOTL	Transmission Operation Tracking & Logging tool which logs transmission outage incidents.
Distribution Underground Network Failure Dataset	Failure incidents in PG&E distribution underground network system
EIR	Electric Incident Report Dataset
Distribution Overhead Outage Dataset	Outage incidents within PG&E distribution overhead assets
Ignition Tracker Dataset	Logs of ignition incidents caused by PG&E assets